PHYSICS AT THE BRITISH ASSOCIATION.

THE interesting way in which Dr. Larmor, in his Presidential Address to Section A, touched on some of the problems of theoretical physics appears to have had a considerable influence on the subsequent proceedings of that section during the meeting at Bradford. At few recent meetings has the number of impromptu discussions of theoretical questions been so great, and even although these discussions may not always have been ended in the settlement of some question previously in dispute, they have provided in a way that only the Association meetings can, opportunities for exchanges of opinions so necessary in these days of specialisation, and so valued by those who have the advance of their subject at heart.

The large section room was well filled for the President's address. After a vote of thanks moved by Prof. FitzGerald and seconded by Principal Oliver Lodge had been carried, a large proportion of the audience left to hear the address of Prof. Perkin, the President of Section B, and the reading of papers commenced. In what follows they are given in order of subject and not of reading.

Dr. Trouton gave a short account of his experiments on the creeping of liquids, and on the surface tensions of mixtures. He has found that the tendency of certain liquids to creep up the sides of their containing vessels is due to such liquids being mixtures. The more volatile constituent creeps in advance of the other, and the action is stopped if evaporation is prevented. Zinc surfaces seem more favourable to the process than surfaces of other metals or of glass. The surface tensions of mixtures of liquids are as a rule less than the values calculated from the surface tensions and proportions of their constituents, while those of salt solutions increase with the number of gram equivalents of the salt present at a rate nearly independent of the nature of the salt, a fact to which Quincke was the first to draw attention.

Prof. G. H. Bryan, in a note on the partition of molecular energy, explained how, in his endeavour to build up irreversible thermal phenomena from reversible dynamics, he had been led to a novel method of investigating the mean distribution of energy amongst a number of particles moving in an external field having a potential. He found that two such particles do not follow Maxwell's law of partition of energy, and concluded that the law would not be followed in a general assemblage of particles. Prof. FitzGerald considered that two particles in an external field did not sufficiently represent the molecules of a gas, and suggested that if the case of three particles had been worked out, they would have been found to follow Maxwell's law. He hoped that physicists would accept that law as valid for gases till a system had been constructed for which it could be proved conclusively not to hold. Prof. Bryan, on the other hand, challenged physicists to construct a simple system of particles which *would* tend towards Maxwell's distribution of energy.

Dr. Larmor gave some results of his application of the principle of least action to the statistical dynamics of gas theory, as illustrated by meteor swarms and optical ray systems. He finds that if a swarm of meteors is moving under its own mutual attractions and conservative outside forces, and if from some point vectors be drawn equal and parallel to the velocities of the meteors, the product of the volume marked out by the ends of these vectors into the volume occupied by the meteors themselves will remain constant throughout the motion. If the mutual attractions are insensible, the product of the solid angle bounded by the velocity vectors into the square of the mean velocity of the swarm will remain constant. In optics this corresponds to the concentration in cross section of a beam being proportional to the solid angular divergence of the beam, into the square of the refractive index of the medium in which it is travelling. In the case of a gas where encounters between the particles may take place, the above distribution of particles and velocities is found to be a possible steady state.

The report of the Seismological Committee was presented by the secretary, Mr. Milne. During the past year he has analysed the records of the earthquakes which occurred during 1899, and has found that the earthquake wave takes about 110 minutes to travel from its origin to the opposite end of the earth's diameter, but whether it is propagated through the centre of the earth or as a surface wave cannot at present be decided. He suggests that earthquakes may be connected with the small changes of latitude known to occur, and that earthquake waves may have a disturbing effect on the timepieces of observatories. Messrs. Clement Reid and Horace Darwin are engaged in an attempt to detect movements at a geological fault owing to earthquakes.

The Committee on the sizes of pages of periodicals reported that it had succeeded in some cases in inducing societies publishing proceedings of exceptional sizes to conform to the rules the committee laid down in its 1895 report. It did not seek re-appointment.

A paper on the relation of radiation to temperature was contributed by Dr. Larmor. The late Prof. Balfour Stewart pointed out at the meeting of the Association in 1871 that if an enclosure at constant temperature contained a moving body at the same temperature, the radiation received from the body at a point in advance would, by Döppler's principle, differ from that received by a point behind the body. Dr. Larmor applies this principle to the case of a spherical enclosure shrinking in size, in which, therefore, the wave-lengths of all radiations will decrease as the radius. Further, there will be a pressure of the radiation on the inside surface of the sphere, which will require work to be performed during the shrinkage. This work is converted into radiation, and changes the temperature of the radiation inversely as the radius, and the energy of the radiation inversely as the fourth power of the radius. From this Stefan's law that radiation is proportional to the fourth power of the temperature follows; and further, the energy of radiation between λ and $\lambda + d\lambda$ is of the form $\lambda^{-5} f(\lambda T).\delta\lambda$. Prof. FitzGerald pointed out the great simplification which Dr. Larmor had introduced into the treatment of the problem by the consideration of the radiation in the ether only, a method of which the legitimacy could not be doubted.

Dr. S. P. Langley sent over from America a chart of the infra red spectrum from ·7 to 5·3 μ, obtained by the bolometric method described in his communication to the Association at Oxford in 1894. His bolometer is now arranged so that a difference of temperature of one-millionth of a degree centigrade is detected; and the whole operation of producing the charts is automatic. They show distinctly the variation of atmospheric absorption with the seasons, and may possibly, he thinks, lead to a new method of weather forecasting.

The Committee on Meteorological Photography reported that as the result of about 400 photographic observations of clouds made from two stations near Exeter, the following mean heights have been found:—Cirrus, 10,200; cirro-cumulus, 8600; cumulus top, 3000; base, 1300; strata-cumulus, 2200 metres. During the early part of the day the clouds rise, attain their maximum altitudes about 2 or 3 p.m., and fall during the afternoon and evening. The greatest altitudes are associated with thunderstorms and the lowest with cyclones.

The Committee on Solar Radiation reported that experiments had been made under the direction of Prof. Callendar, with a view to testing the modified copper-cube actinometer and reducing its records to an absolute scale. During the course of these experiments it has been found necessary to introduce further changes, and the instrument now used consists of a blackened copper disc provided with thermojunctions, suspended within a tubular water jacket around which a stream of water at constant temperature is maintained. The radiation to be measured passes down the tube and falls normally on the copper disc. This instrument has been tested by exposing it to the radiation from an electric lamp at a known distance, and has been found capable of giving consistent results for weak radiation, but the intensity of solar radiation is too great to permit the elementary theory of the instrument to be applied. It is, therefore, proposed at present to record only the *vertical* component of the radiation from sun and sky by means of the bolometric method described in the 1898 report. Two flat platinum thermometers, one bright and the other blackened, are placed horizontally side by side and exposed to the radiation from the sky. Their difference of temperature is automatically recorded, and is taken to be proportional to the radiation to which they are exposed. By means of an observation with an electric lamp at a fixed distance, the indications of the instrument can be converted into absolute measure.

Mr. A. S. Davies described a novel form of mercurial barometer, in which a fixed volume of the gas the pressure of which is to be determined, is compressed isothermally by a column of mercury of known length and the compression measured. The instrument consists of a glass bulb, from which a tube of small bore projects downwards, and ends in another bulb open to the air and containing a little mercury. When a reading is required, the instrument is inverted so that a column of mercury runs down the tube towards the first bulb and compresses the air in it. From the position taken up by the end of this column, when the compressed gas has cooled to its original temperature, the original pressure of the gas can, if the gas is dry, be found. In the instrument this pressure is read off on a scale alongside the tube. The air enclosed is dried by passage through a plug containing calcium chloride. The instrument is very compact and portable.

Mr. A. L. Rotch contributed a note on the use of kites for meteorological observations at Blue Hill Observatory, Mass. Observations with kites have been made up to 16,000 feet above sea level, and have been reduced and published in abstract in NATURE, July 12 and August 9.

Captain Campbell Hepworth exhibited and discussed some charts illustrating the weather of the North Atlantic Ocean during the winter of 1898-9. At sea this period was one of violent storms, while the weather in America was exceptionally cold, and in Europe very mild. Some of the cyclones crossed quickly from the American coast to the British Isles, while others—in particular the worst one in February—made slow progress. Much damage was done to shipping, and even powerful vessels, like the *Lucania* and the *Fürst Bismarck*, were unable to make headway, and arrived at their destinations several days late.

Mr. J. W. Thomas, in a communication on the physical effects of wind in towns and their influence upon ventilation, pointed out that the well-known effect of currents of air in diminishing the air pressure in vessels across the openings of which they passed, was generally neglected by writers on ventilation. A gusty wind, during its period of maximum velocity, reduces the air pressure in a room by the withdrawal of air through the chimney. When the wind lulls, the air passes down the chimney into the room, and the chimney "smokes."

Mr. J. Hopkinson gave an account of the rainfall of the northern counties of England. The means for the ten years ending 1890 are:—

Cumberland, 57·9; Westmoreland, 55·9; Derbyshire, 40·2; Lancashire, 38·3; Yorkshire, 33·4; Cheshire, 31·3; Northumberland, 31·0; Durham, 28·1; Nottinghamshire, 24·4; Lincolnshire, 24·3 inches per annum. These numbers show distinctly the effect of highlands in increasing the average rainfall.

Mr. G. E. Petavel described the apparatus he is using in his experiments on the explosive pressures of gases. He measures the maximum pressure attained in his explosion vessel by means of a piston which is forced out and makes a telephone contact if the pressure exceeds a certain value. By means of the compression of a cylinder he measures also the rate of change of the pressure. He finds that in the case of hydrogen and oxygen the maximum is about ten times the initial pressure, and that inert gases delay but do not greatly diminish the maximum pressure.

Mr. J. W. Gifford gave an account of a quartz-calcite lens he had designed, having the same focal length for wave-lengths 5607 and 2761, which he considers may be taken as the centres of the visual and photographic portions of the spectrum respectively.

Messrs. A. Dufton and W. M. Gardner exhibited at the Technical College an arrangement they had devised for the production of an artificial light of the same character as daylight. Such an artificial light has been much wanted by those engaged in dealing with coloured stuffs, and the practical demonstration given by the authors showed that they have successfully supplied this want. They use an enclosed arc lamp, and surround the translucent bulb of the lamp by a tank containing a solution of copper sulphate of the proper strength, or by a box with sides of glass of the same colour and the requisite thickness.

Mr. H. Ramage described his method of investigating correspondences between spectra. He takes wave frequency as abscissæ, and atomic weights of the elements whose spectra are to be compared as ordinates, and joins by lines the "corresponding" points of the various spectra. These lines are in general curved, and in the case of the components of a doublet their distance apart increases with the atomic weight. If the squares of the atomic weights are taken as ordinates, they become straight lines intersecting on the axis of wave frequency. He proposes, therefore, to introduce a term aW^2, where a is a constant, and W the atomic weight, into Rydberg's formula, which will thus become $n = n_0 - aW^2 - \frac{N_0}{(m-\mu)^2}$.

Mr. G. J. Burch exhibited an experiment on simultaneous contrast. One half of the slide of a stereoscope consists of blue and the other of red glass. By means of diffraction gratings in the eyepiece of the stereoscope, two spectra are produced which appear to cover two patches of black paper on the two glasses. Under these circumstances, that seen by the eye which looks at the red glass appears to lack red, the eye being partially blinded for red, the other for a similar reason lacks blue. In Mr. Burch's opinion these facts confirm the views of Thomas Young on colour contrast.

The Committee for improving the method of determining Magnetic Force on Board Ship reported that an instrument had been constructed according to the designs of Captain Creak, which gave promise of overcoming many of the difficulties met with in using Fox's circle.

The work of the Committee on Radiation in a Magnetic Field had been interrupted by the death of Mr. Preston, but the committee now proposed to issue copies of Preston's photographs showing how the various types of lines are affected by the magnetic field.

The Electrical Standards Committee reported that the standards had been removed to Kew, where an outbuilding had been fitted up for the temporary use of the committee of the National Physical Laboratory. The sub-committee on platinum thermometry has decided that platinum thermometers shall be constructed of a selected sample of platinum wire, and be used as standards for high temperature measurements. The selection of wire is still under the consideration of the committee. Arrangements have been made for the construction of a mercury resistance standard and an ampere balance. The Committee approves of the adoption of the names *Gauss* and *Maxwell* for the C.G.S. units of magnetic field and flux respectively.

Mr. R. S. Whipple gave an account of his improved standard resistance coils. Alongside the platinum-silver wire of the standard coil a second wire of platinum is wound. The difference of resistance of the two coils depends on their temperature, which may therefore be regulated to have any required value. Dr. R. T. Glazebrook pointed out that the method had been used by Messrs. Crompton in constructing their standard resistances.

Mr. E. H. Griffiths described the form of Wheatstone bridge he has devised for determining the freezing-points of dilute solutions by platinum thermometry. A platinum thermometer of about 18 ohms resistance placed in the solution, and another similar one in ice, form two of the arms of a Wheatstone bridge. The rest of the bridge is of platinum. The galvanometer is connected to the bridge by means of two sliders, each of which moves along a pair of platinum wires, one of the pair forming part of the bridge, and the other connected permanently to the galvanometer. The readings of these sliders for a balance determine the difference of temperature of the two thermometers. Using a Paschen galvanometer giving a deflection of 1 mm. on a scale 1 metre distant for a current of 10^{-12} ampere, Mr. Griffiths can determine temperature to one-millionth of a degree centigrade. Mr. R. Threlfall pointed out that although the temperature of the platinum wire of the thermometer could be determined to this degree of accuracy, the temperature of the solution could not. In reply to Dr. Glazebrook, Mr. Griffiths stated that the mercury contacts in Carey Foster's method introduced changes which prevented this high degree of accuracy being attained with it.

Prof. F. G. Baily described a lecture-room form of volt and ammeter which he had devised. By means of a series of resistance coils all contained in a small box, the deflections of a galvanometer of the d'Arsonval type are made to correspond to simple multiples or submultiples of a volt or an ampere.

Prof. W. B. Morton communicated some results he had obtained by applying J. J. Thomson's and Sommerfeld's solution of the propagation of an electric wave along a single wire, to the approximate solution of cases of several parallel wires, some of which may be returns, when the square of the ratio of the radii of the wires to their distances apart may be neglected. His results agree with the more complete investigations given by Mie in the June number of the *Annalen der Physik*.

A communication from Mr. S. H. Burbury on the vector potential of electric currents in a field where disturbances are propagated with finite velocity, was, in the absence of the author, taken as read. There are difficulties in the way of the usual definition of the vector potential due to electric currents when these currents are changing. These difficulties Mr. Burbury proposes to obviate by substituting in the definition, for the current at a given point at the given instant, the current which existed at that point r/V seconds before, where r is the distance of the point from that at which the vector potential is to be measured, and V is the velocity of propagation of an electric disturbance.

The communication which most attracted the attention of the members of the Association, and produced a great addition to the attendance at Section A, was that of Sir William H. Preece on wireless telephony. By a series of experiments carried out at Lock Ness, the Menai Straits, the Skerries and at Rathlin Island, he has shown conclusively that wireless telephony is a practical and commercial system. At the Skerries a line half a mile long terminated by earth plates placed in the sea, at a mean distance of nearly three miles from a similar wire three and a half miles long on the mainland, was quite sufficient to enable telephonic messages to be transmitted with the ordinary instruments. At Rathlin Island the wire is eight miles from the mainland and communication is readily maintained. Endeavours are to be made to extend the system to ships and there seems every probability of success.

Prof. G. F. FitzGerald, in a note on Crémieu's experiment, described the arrangement adopted by Mr. Crémieu and the negative result he had obtained, and contrasted them with the arrangement and result obtained by Rowland in his experiments on electric convection made in 1876. He considered that the discrepancy of the results of experiments, which appeared to have been carried out with great care, did not necessarily disprove our theory of electromagnetism, but rather signified that there was some action of a moving ion not hitherto included in our equations which was well worth investigating. Dr. J. Larmor pointed out that any want of symmetry of the revolving disc and fixed case in Crémieu's apparatus would tend to cause some part of the charge on the disc to remain stationary. Prof. A. Gray announced that he had already commenced work with a view to repeating both Rowland's and Crémieu's experiments with the same apparatus.

Prof. J. Chunder Bose gave an account of his work on the effect of electrical stimulus on inorganic and living substances. By measurements of conductivity he determines the magnitudes of the changes produced in the molecular structure of substances due to an electric stimulus. Taking time of exposure to stimulus, or time of recovery from effect of stimulus, as abscissæ, and change of conductivity as ordinates, he draws curves for numerous substances under varying conditions. He finds that the curves for organic and inorganic substances are similar. On this as a basis he has constructed an artificial retina, which has enabled him to explain many obscure phenomena of vision.

The Committee on Electrolysis and Electro-chemistry reported that the experiments on the freezing points of the solutions whose electrical conductivities had been found by Mr. Whetham were still in progress. Some experiments on the consumption of carbon anodes in electrolysis have been made by Mr. Skinner, who has found that the anion produced by electrolysis of any highly oxidised material consists partly of carbonic acid. The committee now lapses.

Prof. G. F. FitzGerald opened a joint discussion with the chemical section, on ions. While acknowledging that the dissociation theory of electrolysis had proved a useful hypothesis, he wished to draw attention to the fact that there were phenomena which it was incapable of explaining, and that dissociation itself had not been dynamically explained. Why should water dissociate a dissolved salt into its ions? where does the necessary energy come from? how can the dissociated ions wander about in the solvent without recombining? and why do some ions travel faster than others? seemed to him questions which the supporters of the theory had never satisfactorily answered. The recent work on conduction in gases seemed to render it necessary to restrict the term "ionisation" in future to the process of producing atoms differently electrified, and to introduce a new term "electronisation" for the production of conductivity by the motion of particles of apparent mass about 1/500 of that of a hydrogen atom. In gases conductivity was probably due to both causes, and in liquids to the former only. In the case of metals, he should like to ask, how thick was the layer of electricity on the surface? did the thickness of a thin metal plate alter its capacity? and would the electrons fly to the surface of a metal when it revolved? He thought the questions still open to discussion might be summarised as follows:—

(1) The cause and nature of ionisation.

(2) The source of the energy in dissociation in a liquid.

(3) The cause of the failure of the law of dissociation as the concentration increased.

(4) The reason for the different rates of migration of the ions.

(5) The nature of the double layers, or why different metals should attract electricity differently.

(6) Are the processes of ionisation the same in liquids and gases? and, if so, why?

(7) Do electrons gravitate, *i.e.* have they a material nucleus or not?

(8) Is magnetism due to rotation of the electrons?

Dr. Larmor, before calling on the chemists present for their remarks, pointed out that the large dielectric constant of water meant a large electric moment for the water molecule, and therefore a considerable separation of the positive and negative charges on the molecule. A molecule of dissolved salt might therefore readily come under the influence of one of these charges alone.

Prof. H. E. Armstrong stated that in the opinion of chemists the atoms were permanent and stable, and that the removal of 1/500 of the mass of a hydrogen atom along with its negative charge seemed to them impossible. He thought that the same process produced conductivity in gases which produced it in liquids; that in gases the vapour of water played the part of the water in electrolysis of a dissolved salt, and that in all cases it was necessary to form a "triplet" by the presence of a third substance, before any chemical or other action could result. This third substance was generally one having one of its constituents in an "unsatisfied" condition, like the oxygen in water or the nitrogen in ammonia, and in which there was in consequence a tendency towards "association" of molecules.

Mr. Whetham stated by letter that he did not think the difficulties of the dissociation theory were as great as they were represented. The ions might be free from each other but be connected with the molecules of the solvent.

Principal Oliver Lodge thought that although in a liquid the charges apparently travelled with the atoms, while in a gas the electrons appeared to be free, in neither case was conduction by means of molecular aggregates excluded. He considered metallic conduction the handing on of the electrons from one atom to another. He looked forward to an electrical theory of matter, in which the hydrogen atom would consist simply of 500 electrons without nuclei.

Mr. W. J. Pope pointed out that the dissociation theory only held up to concentrations of 5 per cent., and that there was a difficulty in the case of salts which on account of their asymmetry rotated the plane of polarisation of light.

Dr. H. C. Pocklington gave an account of his work on the radiation of a black body on the electro-magnetic theory. Assuming that the energy of the total radiation emitted by a black body at any temperature is the product of powers of the temperature θ, the velocity of propagation of the radiation v, and the atomic charge Q, Dr. Pocklington finds by the theory of dimensions that the power of the temperature is 4, *i.e.* Stefan's law, and that the radiation between λ and $\lambda + \delta\lambda$ is proportional to

$$\theta^4 \cdot v \cdot Q^{-6} \frac{d\lambda}{\lambda} \cdot f\left(\frac{\theta\lambda}{Q^2}\right),$$

in agreement with Wien's law.

Mr. C. E. S. Phillips gave an account of his experiments on the apparent emission of kathode rays from an electrode at zero potential. He has found that the green flecks which make their appearance on the inner surface of a partially exhausted vacuum bulb when a discharge passes, are due to the emission from the kathode of jets of occluded gas, which continue even when the two electrodes of the bulb are both earth connected. These jets produce shadows of opaque bodies held in their path, and although their velocity is probably not greater than that of sound, they can cause the green fluorescence in the glass on which they impinge.

Mr. J. B. B. Burke communicated a paper on the phosphorescent glow in gases. He uses electrodeless tubes, and finds that the glow begins to appear at a pressure of ·7 mm., is a maximum at ·1, and disappears at ·02 mm. of mercury. It seems to be composed of two parts, one carrying the charge, the other uncharged, but capable of producing conductivity in those parts of the tube to which it penetrates. The conductivity effect is propagated quickly, but the glow appears to be propagated by diffusion along the tube. Prof. A. Smithells mentioned that his experiments on flame showed that the emission of light from the flame was in the same way independent of the conductivity of the flame.

At the close of the meeting of the section on Wednesday morning, September 12, votes of thanks to the president and secretaries were passed, and the section adjourned to Glasgow.

C. H. LEES.

ASTRONOMY AT THE BRITISH ASSOCIATION.

ASTRONOMY this year constituted a distinct department of Section A, with its own chairman and secretaries, and a separate room was provided for the reading of papers on this subject. The new departure was sufficiently justified by the attendance at the meetings, and in future years, when the formation of the Department of Astronomy becomes more widely known, increased success may be confidently expected. The department met on Friday, September 7, and Tuesday, September 11, and altogether sixteen papers were read.

At Friday's meeting, after the chairman's address, three papers by Prof. Todd, relating to eclipse work, were read by one of the secretaries in the absence of the author. In one of these attention was called to the "application of the electric telegraph to the furtherance of eclipse research." In 1878, the idea first occurred to Prof. Todd to telegraph eastward in advance of the lunar shadow in order to enable the immediate verification of any possible discovery, as of an intramercurian planet, without waiting for another eclipse. The feasibility of the method was demonstrated in January 1889, and again more completely during the eclipse of May 28, 1900. At the station occupied by Mr. Douglas in Georgia, totality preceded the same phenomena in Tripoli, where Prof. Todd himself was observing, by 2h. 45m., and the outcome of the experiment was that, through the generous help afforded by the various telegraph companies, an account of the American observations was received by Prof. Todd more than two hours before totality occurred at Tripoli. Abundant time for special preparations to verify any important discovery was thus available.

In his second paper Prof. Todd dealt with a variety of methods of operating eclipse instruments automatically. The "mechanical system," as distinct from the pneumatic and electric arrangements which he had previously devised, was first tried during the recent eclipse. The instruments being set up on the roof of the British Consulate, gravity was utilised for the mechanical operation of slides and shutters. One hundred photographs were secured at Tripoli by seven instruments operated in this manner. Experience indicates that the gravity method is the best where the number of instruments is not great.

Another paper by Prof. Todd described the use of a wedge of yellow optical glass in giving correctly graduated exposures of the partial phases and corona on a single biograph film.

An important paper on the classification of sun-spots was read by the Rev. A. L. Corti, S.J., and illustrated by a fine series of lantern slides selected from the thousands of drawings made at Stonyhurst during the last twenty years. Five types, with a certain number of sub-divisions, were found sufficient to denote the characters of all the spots which had so far been examined.

The chief type, of which the others are probably but phases, is the two-spot formation. The faculæ associated with the different types are also of different characters, and it may be possible to foretell the outburst of a spot by the observation of a certain kind of facula. As an illustration of the use of the type numbers, the life-history of a composite disturbance which crossed the solar disc five times between May 14 and September 4, 1887, was thus described :—

I., II.*b* | IV.*d*, IV.*a* | IV.*a*, IV.*d*, IV.*a* | IV.*a*, I., II.*a* | I.

In the course of the discussion on this paper it became evident that the need for some short system of notation had long been felt by observers of sun-spots, and that, providing the scheme suggested would cover all cases, it would be very valuable. The chairman remarked that possibly a still better system, which would tax the memory less, might be devised on the plan of Herschel's notation for nebulæ.

Prof. Turner exhibited and explained "a cheap form of micrometer for determining star positions on photographic plates." The essential features are a wooden frame to support the photograph, with an attachment carrying a simple microscope containing a scale in the eye-piece. For less than thirty shillings an efficient instrument can be constructed, capable of yielding measures of practical utility. It thus becomes possible for any one to undertake important researches at a much smaller outlay than would be involved in the purchase of a telescope, since there is no lack of material to work upon. Among the investigations mentioned by Prof. Turner as possible with such a machine, were the determination of the positions of nebulæ and comets, and measurements to ascertain the forms of the trails of meteors. Considerable interest in the proposal was displayed, and the hope was expressed that many who now spend their time in fruitless star gazing with small instruments may be induced to undertake these micrometric measurements.

Thursday's meeting was opened with an interesting paper by Dr. Lockyer, in which a comparison was made of the details of the prominences and corona as shown in photographs taken during the recent eclipse at intervals of 2½ hours, by Prof. Langley and Sir Norman Lockyer, in America and Spain respectively. While enormous changes in the prominences were revealed, no change was detected in the structure of the corona in the region of the North Pole, which had been specially investigated. An interesting feature of one of the photographs taken in Spain with an exposure of 40 seconds was the extreme hardness of the moon's limb, notwithstanding the relative motion of the moon during the exposure ; the explanation of this unexpected appearance was based on the rapid diminution in intensity of the corona as the outer layers are reached, so that the momentary exposures of the lower corona on the advancing limb of the moon at the beginning of the exposure, and on the following limb at the end, were sufficient to give a strong impression.

The new form of refracting telescope recently erected at Cambridge, chiefly for photographic work, was described by Mr. A. R. Hinks, and illustrated by lantern slides. The object-glass is a Taylor triple lens of 12½ inches aperture, and the chief peculiarity of the mounting is that the portion which is usually the lower half of the tube forms the polar axis, with the eye-end at the top, while the object-glass end is hinged to the other piece, and a plane mirror is placed at the junction. In another paper Mr. Hinks referred to the preparations which are being made for determining the solar parallax by observations of Eros during the coming winter, and exhibited a series of diagrams showing the path of the Cambridge Observatory as seen from that planet at various times. With the aid of such diagrams the observer can see at a glance the most favourable times for making micrometric measurements or taking photographs for the purpose in hand. The importance of the observations of Eros was emphasised by Prof. Turner, who remarked that at the present time the probable error of the adopted value of the solar parallax was equivalent to the thickness of a wicket in the length of a cricket pitch. Unlike the transit of Venus, the observations of Eros would be easily reduced, and the results of the observations would soon be accessible.

A paper on "some points in connection with the photography of a moving object," by Mr. W. E. Plummer, had an important bearing on the photographic method of ascertaining the position of such a rapidly moving object as the planet Eros. A comparison of measurements of the positions of a comet made with a micrometer and those determined from photographs indicated that considerable errors might be introduced in the photographic results on account of the difficulty of determining the epoch of observation. Since the first few moments of exposure on the moving object leave no impression, the middle of the trail does not correspond to the middle of the exposure. In exposures of ten minutes on Eros the danger of error was very considerable. Mr. Hinks remarked that it was hoped to obtain sufficiently strong impressions of the field containing Eros with exposures of one or two minutes, under favourable circumstances, and, moreover, special precautions to eliminate this difficulty had been arranged at the Paris Conference.

Mr. John Herschel described in detail his method of observing and recording the paths of meteors. Special maps are constructed in which the brighter stars are represented by perforations made with needles of various sizes, the side of the paper away from the observer being blue, while that towards him is white. The map being laid on a sloping desk of ground glass illuminated by a night light, the paths of the meteors are ruled in by means of a transparent celluloid ruler having a black edge.